 ICES-2016-074

U.S. Spacesuit Knowledge Capture Accomplishments in Fiscal Year 2015

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The NASA U.S. Spacesuit Knowledge Capture (SKC) Program continues to capture, share, and archive significant spacesuit-related knowledge with engineers and other technical staff and invested entities. Since its 2007 inception, the SKC Program has hosted and recorded more than 75 events. By the end of Fiscal Year (FY) 2015, 40 of these were processed and uploaded to a publically accessible NASA Web site where viewers can expand their knowledge about the spacesuit's evolution, known capabilities and limitations, and lessons learned. Sharing this knowledge with entities beyond NASA can increase not only more people's understanding of the technical effort and importance involved in designing a spacesuit, it can also expand the interest and support in this valuable program that ensures significant knowledge is retained and accessible. This paper discusses the FY 2015 SKC events, the release and accessibility of the approved events, and the program's future plans.

Nomenclature

CAIB	=	Columbia Accident Investigation Board
CTSD	=	Crew and Thermal Systems Division
DAA	=	Document Availability Authorization
EA	=	Engineering Directorate
EC	=	Crew and Thermal Systems Division
EMU	=	Extravehicular Mobility Unit
EVA	=	extravehicular activity
FY	=	Fiscal Year
ISS	=	International Space Station
JSC	=	Johnson Space Center
K-CAP	=	knowledge capture [lessons]
MTSO	=	Management and Technical Support Office
NASM	=	National Air and Space Museum
NCE	=	NESC [NASA Engineering and Safety Center] chief engineers
NESC	=	NASA Engineering and Safety Center
NPD	=	NASA Policy Directive
NRB	=	NESC [NASA Engineering and Safety Center] Review Board
PE	=	principal engineer
PLSS	=	portable life support system
SEO	=	Systems Engineering Office
SIPI	=	Southwestern Indian Polytechnic Institute

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SKC = U.S. Spacesuit Knowledge Capture
SME = subject-matter expert
STEM = science, technology, engineering, and math
STI = Scientific and Technical Information
SWME = Spacesuit Water Membrane Evaporator
TDT = Technical Discipline Team
TCU = Tribal Colleges and Universities

I. Introduction

By February 2016, NASA received over 18,300 résumés from applicants hoping to fill the 8 to 14 astronaut openings. With this position's record-breaking number of applicants, young Americans are showing their desire to continue and be part of human space exploration.[1] To be an astronaut, the requirements include having bachelor's degree in engineering, biological science, physical science, or mathematics; the ability to pass the NASA long-duration space flight physical; and a well-designed spacesuit that will protect the astronaut while also allowing him or her to do tactile tasks in space.[2] With an interest to help fulfill NASA's mission to explore deep space and harness an asteroid before sending humans to Mars, the U.S. spacesuit remains a priority for NASA. Designing a spacesuit to perform the onerous tasks demanded of the hazardous space environment requires design, failure, redesign, and troubleshooting knowledge. These are topics that the U.S. Spacesuit Knowledge Capture (SKC) Program collects and shares with spacesuit developers to design future spacesuits to prepare for human travel into deep space.

Since the SKC Program's 2007 inception, the team realized the importance of archiving and sharing historic spacesuit knowledge, and in 2008, the Johnson Space Center (JSC) Policy Directive encouraged JSC organizations to promote knowledge transfer, collaborative sharing, and learning required for the success of the NASA missions; this spurred the SKC Program.[3] The JSC Space Suit & Crew Survival Systems Branch manages the SKC Program.

As the needs of the spacesuit design change with those of the Agency's mission or with additional knowledge, the SKC Program assesses what information is needed to share with JSC NASA engineers, scientists, and managers to augment their work. With this in mind, the SKC Program collects historical and current spacesuit information and peripheral topics that enhance the development of spacesuits through lectures, courses, and interviews with subject-matter experts (SME) that the program hosts. Figure 1 is a representation of the SKC Program as it portrays NASA's spacesuit over the last several decades.

Figure 1. A selection of images showing the functions of spacesuits (image by Jeannie Corte and Blake Dumesnil).

The SKC Program focuses on the spacesuit's rich history and more, and uses related knowledge shared by spacesuit SMEs to enlighten current and future engineers, scientists, and various technical specialists. Through specific subject-matter events, these SMEs recall their experience with spacesuits and other ancillary spacesuit-related topics and give recommendations. From these courses, students extrapolate lessons learned. These events are preserved in printed, video, and audio formats and were initially provided to JSC NASA engineers, scientists, and managers to augment their work.

The Southwestern Indian Polytechnic Institute (SIPI), in collaboration with the SKC Program, won a grant in Fiscal Year (FY) 2014, which prompted the SKC Program to expand its primary audience beyond NASA. As a result, the SKC Program began offering additional events in FY 2015 that shared specific knowledge suited to college and high school level students.

Since the SKC Program's inception, it has hosted and archived 77 events. To maintain the value of this enormous amount of information collected, it must be used effectively. As a way to encourage its use, the SKC Program's information is now stored on NASA domains, with restricted and public access readily available to current spacesuit developers, technical human mission contributors, science, technology, engineering, and math (STEM) students, and any interested viewer.

The SKC Program has been publishing its accomplishments since its 2011 paper titled "U.S. Spacesuit Knowledge Capture."[4] The "U.S. Spacesuit Knowledge Capture Status and Initiatives" paper highlights NASA's SKC Program from inception through June of FY 2012,[3] and the paper titled "U.S. Spacesuit Knowledge Capture Accomplishments in Fiscal Years 2012 and 2013" focuses on SKC events from July FY 2012 through FY 2013.[5] FY 2014 resulted in no SKC events. The SKC Program used this time to focus on processing its existing events to obtain approval for public release and determine a means of accessing this valuable information. Also, in FY 2014, the NASA Engineering and Safety Center (NESC) became a chief funder of the SKC Program and began helping the program prepare its information to be viewed on five NASA domains, some of which are publically accessible. The "U.S. Spacesuit Knowledge Capture Accomplishments in Fiscal Year 2014" describes the SKC Program's purpose and the NESC's contribution to it, identifies the approved-for-public-release events, and explains how to access them. This paper, "U.S. Spacesuit Knowledge Capture Accomplishments in Fiscal Year 2015," discusses the program's FY 2015 accomplishments and describes how it expanded its audience.

II. Engineering and Safety Center and its Contribution

The NESC was formed in July 2003 as a result of the Space Shuttle Columbia incident. The Columbia Accident Investigation Board (CAIB) was established thereafter. The CAIB released its report in August 2003, with recommendations to NASA. An executive team, known as the Diaz Team, was chartered by NASA Administrator Sean O'Keefe to identify those CAIB report elements applicable to NASA and to develop measures to address each one. A report published in January 2004, by the Diaz Team, recommended that an independent technical engineering authority concept be implemented for all programs to ensure that technical standards are being met. The report indicated that the approach would supplement the in-line safety, quality, reliability, and mission assurance efforts by providing independence from any perceived conflicts as a result of program budgets and schedules. Thereafter, the NESC would be an enhancement to NASA's independent safety capability.[6]

The NESC remains separate from the NASA mission directorates, programs, projects, and Centers, and which allows independence, objectivity, and flexibility when working with other NASA organizations. The NESC is a unique and world-class technical organization structured to quickly and efficiently address the toughest technical problems as they arise. The NESC falls under NASA's Office of the Chief Engineer as shown in Figure 2. The NESC principal engineers (PE), NESC chief engineers (NCE), NASA technical fellows, Systems Engineering Office (SEO), and the Management and Technical Support Office (MTSO) make up the core team, led by the NESC director and his office. Members of Technical Discipline Teams (TDT) form the NESC extended team. The TDTs are populated with engineers and scientists chosen for their technical knowledge and experience, and drawn from within NASA, academia, industry, or other government agencies. The NESC Review Board (NRB) is the decision body of the NESC and its assessment teams. The NRB is comprised of members from each of the NESC offices, and represents all 10 NASA Centers and each technical discipline.[7]

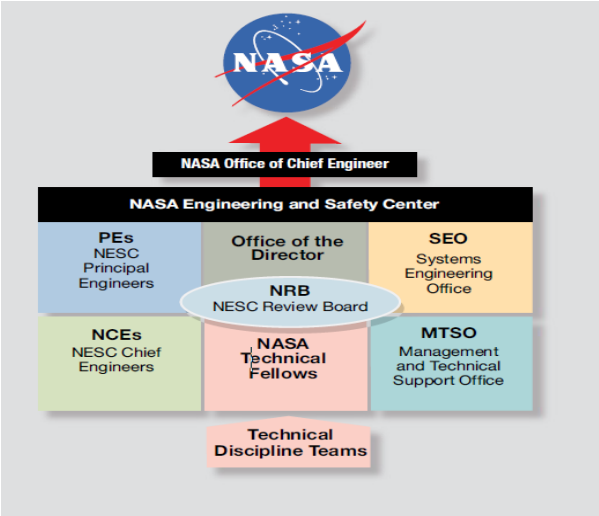

Figure 2. NESC Organization.

The NESC's mission is to perform value-added independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success. The NESC engages proactively to help NASA avoid future problems.[8] Also, the NESC is a knowledge

power house. The NESC shares its acquired knowledge from the hundreds of technical assessments conducted since its inception. The NESC offers a multitude of knowledge services and products that can be readily accessed. These services and products include technical assessments, reports, databases, and videos.[7]

In particular, the NESC's video library is called the "NESC Academy Online," which offers a Web site featuring nearly 300 informative lessons on topics relevant to current NASA issues and challenges. This site is like a virtual classroom offering a myriad of technical topics. The NESC Academy Online videos have received more than 17,000 views since inception in 2012. The NESC continues researching ways to further advertise through social media, partnerships within NASA, cross-linking, and other ways to increase viewership. They anticipate a continued upward trend in views and reach as well as new content being added to the site. The NESC Academy Online videos are found at nescacademy.nasa.gov.[7]

The NESC is processing new content that includes over 70 videos from the SKC Program Series to be made available on the NESC Academy Online. The NESC Academy Online has contributed greatly to the SKC Program's viewership by uploading, archiving, and advertising the program's approved events. The NESC is being established as the primary repository of information for SKC events. The NESC team is working with the SKC Program to collaborate with four NASA access sites, each currently used to archive SKC events, to simplify the archiving of recorded SKC events. This collaboration will involve sharing an embed code that allows these additional sites to tie into the NESC's server and advertise the SKC's publically accessible and restricted events. Because these Web sites are connected to the NESC's server, viewers will be asked to authenticate their credentials with NASA before they can access restricted files.

The Environmental Control and Life Support System and Active Thermal Systems technical fellow, Henry (Hank) Rotter shown in Figure 3, facilitated the archiving of the SKC series with the NESC Academy Online as he recognized the significance of the information. The NESC Academy Online will now provide a repository for the plethora of valuable spacesuit information including lessons learned, which fits within Mr. Rotter's discipline as a technical fellow at the NESC. Mr. Rotter's support, which was initiated in 2014, has allowed the SKC Program to continue processing its recorded information and has given the information a permanent home, which is easily accessible by the NASA and spacesuit community, along with the public.

NESC Academy Online

Figure 3. Mr. Hank Rotter. *NASA technical fellow for Life Support and Active Thermal Control Systems.*

III. Published Accomplishments and Events

Since the SKC Program's inception, it has hosted and recorded 77 events (Table 1). Seventy-two of these have been submitted into the NASA Document Availability Authorization (DAA) system to be processed and approved for public or restricted access. Fifty-five events are being archived on the NESC Academy Online, and are accessible as described in Section IV of this paper. Fifty-one of these events have been approved for public release (Table 2). Four events have been processed and archived with restricted access. These four events are accessible by NASA employees and contractors only. Five events contain classified information and are archived with the SKC Program behind a firewall. The remaining 17 events are still in the DAA-approval process. Several of the approved-for-public-release events are also available on the NASA Scientific and Technical Information (STI) Program's YouTube, the Engineering Directorate (EA) Engineering Academy, the JSC History Office, and the SKC domains. The events have included lectures, training courses, lunch-and-learns, workshops, and interviews with SMEs. Each event contains valuable information, and after it is approved for release, it is readily available to engineers and various technical specialists, along with other interested viewers who may include educators and students. This knowledge can help users advance the U.S. spacesuit beyond the boundaries of current technical achievements or improve their own understanding and perseverance of a spacesuit-related profession or interest. Each event is electronically recorded and includes the presenters' slides and verbal presentations along with the responses to attendees' questions asked during the event.

Table 1. Status of SKC Events

Status of Event	Number		
Publically available	51	Being processed by NESC Academy Online	Submitted into DAA System 72 events
Restricted access	4		
In DAA-approval	17		
Classified	5		
Hosted & recorded	77		

Before an event is released internally to NASA employees and contractors or to the public, all documented and electronically recorded material that is part of the event is processed in adherence to NASA Policy Directive (NPD) 2200.1C.[9] This approval process, from the event's inception to its release, is discussed in more detail in "U.S. Spacesuit Knowledge Capture Accomplishments in Fiscal Year 2014."[10]

Table 2. Approved-for-public-release events

Date Presented	Presenter	Title of Event
1/14/2008	G. Ryan Lee	Implications of Operational Pressure
2/22/2008	Garret Fitzpatrick	Gen Y Perspectives
2/28/2008	Bruce Conger	Baseline Constellation PLSS Schematic Functions and Operational Modes
3/27/2008	Gretchen A. Thomas and Amy J. Ross	Arizona Geology Field Trip
4/18/2008	Gretchen A. Thomas	Rules of Thumb for Cost Estimating
5/20/2008	Joey Marmolejo, Chris Estrada, Chuck Fulcher, and Brian Peavey	Orlan-M Spacesuit Familiarization Class
6/13/2008	Amy Ross	Gloves 101
12/1-2/2008	Joe McMann	Failure Recovery
8/26/2010	Cinda Chullen and William (Bill) West	Post-Shuttle EVA Operations on ISS
2/17/2010	Lewis Croog	Chinese Spacesuit Analysis
3/15/2010	Dr. Dean Eppler	Conduct of Geologic Field Work during Planetary Exploration: Why Geology Matters

Table 2. Approved-for-public-release events (continued)

Date Presented	Presenter	Title of Event
5/20-21/2010	Joe McMann and Mike Rouen	EMU Certification Workshop
6/25/2010	B. Mike Lawson	The Size of the Universe and Where Will We Go?
9/28/2010	Mallory Jennings and Dr. Glenn Waguespack	Constellation Spacesuit PLSS Trace Contaminant Control
9/30/2010	Grant Bue & Matthew Vogel	Design and Testing of the Sheet and Hollow Fiber Spacesuit Water Membrane Evaporators
10/28/2010	Jennifer Matty	Joint Mobility
1/25/2011	Amy J. Ross	Suit 101
3/31/2011	Gretchen A. Thomas	PLSS 101
12/16/2010	B. Mike Lawson	Mike Lawson's Stories and More
6/30/2011	Joe Chambliss	Alternate Approaches to Exploration – The Single Crew Module Concept
8/16/2011	Joe McMann (interviewed by Pica Kahn)	An Interview with Joe McMann: Lessons Learned in Human and Hardware Behavior
10/20/2011	Mallory Jennings	Packing the PLSS
11/29/2011	Carly Watts and Bruce Conger	PLSS 1.0 Breadboard – Schematics
12/6/2011	Joe Kosmo (interviewed by Amy J. Ross)	Kosmo's Farewell Advice
12/8/2011	Joe McMann	Fifty Years of Observing Hardware and Human Behavior
1/19/2012	Joe McMann and Paul Shack	Shuttle EMU Electronics/Avionics Development Experience as Related to Advanced EMU Development
5/10/2012	Tom Sanzone	The Good Old Days of CTSD
1/24/2012	Dr. Scott Parazynski	EVA Physiology & Medical Considerations Working in the Suit
2/23/2012	Dr. Scott Parazynski	TPS Inspection and Repair
3/6/2012	Dr. Scott Parazynski	EVA Skills Training
3/28/2012	Ron Woods (interviewed by Rebecca Wright)	Apollo, Paintbrushes, and Packaging: An Interview with 40-year Spacesuit Veteran Ron Woods
4/19/2012	Ron Woods	Lessons Learned From a Ship-and-Shoot Philosophy
4/26/2012	Ron Woods	The Road to Final Stow
5/14/2012	Dr. Cathleen Lewis (interviewed by Rebecca Wright)	Interview with Smithsonian NASM Spacesuit Curator Dr. Cathleen Lewis
6/19/2012	Grant Bue & Janice Makinen	SWME Development and Testing for the Advanced Spacesuit
6/25/2012	Joe McMann	PLSS Design and Manufacturing Review Debrief
8/14/2012	Juniper Jairala and Robert Durkin	EVA Development and Verification Testing at NASA's Neutral Buoyancy Laboratory
9/28/2012	Jim McBarron (interviewed by Rebecca Wright)	Personal Background Interview of Jim McBarron

Table 2. Approved-for-public-release events (continued)

Date Presented	Presenter	Title of Event
10/16/2012	Joe Chambliss	The Single Habitat Module Concept – A Streamlined Way to Explore
11/6/2012	Jim McBarron	Spacesuit Development and Qualification for Project Mercury
12/4/2012	Jim McBarron	Spacesuit Development and Qualification for Project Gemini
1/29/2013	Jim McBarron	Apollo Block I Spacesuit Development and Apollo Block II Spacesuit Competition
4/10/2013	Kenneth Thomas	Launch, Entry & Abort, Intra-Vehicular Spacesuits
5/6/2013	Dr. Stan Love	Antarctica EVA
7/25/2013	Dr. Paul Abell	Human Exploration of Near-Earth Asteroids
7/31/2013	Dr. Stan Love	Near-Earth Asteroids: Threats and Opportunities
9/17/2013	Dr. Jonathan B. Clark	Overview of Spacesuits for Survival and Escape
1/21/2015	Jim McBarron	Early Apollo Spacesuit Development, A-7L Suit Requirements, and Design Details
1/28/2015	Jim McBarron	Apollo A-7L Spacesuit Certification and Mission Operations Details
5/13/2015	Scott Askew	Robonaut 2: The First Humanoid Robot in Space and its Technology Spin-offs
6/24/2015	Jim McBarron	Apollo Spacesuit Modifications for the Apollo-Soyuz Project

The "U.S. Spacesuit Knowledge Capture Series Catalog Revision B" Crew and Thermal Systems Division (CTSD)–SS–3487 documents all the SKC events that occurred since the program's inception through FY 2015, including publically accessible, restricted, and sensitive events. The catalog also includes the event's topic, synopsis, presenter, and each presenter's biography and photograph. The catalog will be available through the YouTube site [http://www.youtube.com/playlist?list=PL30B1C44470174A66].

IV. Access to U.S. Spacesuit Knowledge Capture Program Information

The NESC team receives all DAA-processed and approved SKC event files and reviews; edits; adds searchable closed captioning to each video, making its site 508 compliant; and uploads the approved event files. The DAA-approved-with-restricted-access files are also uploaded to the NESC Academy Online, and are protected to allow access only to NASA employees and contractors. DAA-approved files are also archived on the following Web sites:

- STI Program's YouTube
- EA Engineering Academy
- JSC History Office
- SKC

As the recorded events are processed and approved for public release, the recordings and related printed documentation are distributed to the NECS Academy Online where the files are archived and uploaded. The NESC team collaborates with the NASA STI Program's YouTube, EA Engineering Academy, JSC History Office, and SKC representatives, making the approved events accessible on these domains as well. Table 3 shows the links where these files can be accessed, and also indicates who can access them. At the conclusion of each event, the SKC Program shares access to these files with the attendees by distributing a bookmark with a map to these domains, as illustrated in Figure 4.

Table 3. How to Access SKC Program Knowledge

Domain	About this Site	Link	Accessibility
NESC Academy Online	Technical information stored here is available through the NESC Academy Online and other viable NASA entities. Files with restricted access archived at this site require special credentials to be retrieved.	http://nescacademy.nasa.gov/video_catalog.php?catid=5&subcatid=27	NASA community and the public
NASA STI Program's YouTube	The NASA STI Program's YouTube is located within the NASA STI Program, a program that archives technical knowledge and lessons learned.	http://www.youtube.com/playlist?list=PL30B1C44470174A66&feature=plcp	NASA community and the public
EA Engineering Academy	The EA Engineering Academy Web site collects and disseminates technical information that includes training, development, and learning resources.	http://ea.jsc.nasa.gov/Ea_web/html/emplsrv/academy/index.asp	JSC employees only
JSC History Office	The JSC History Office gathers and archives the JSC History Database, JSC Oral Histories, and various recorded JSC history through hundreds of Web sites.	http://www.jsc.nasa.gov/history/spacesuits/index.htm	NASA community and the public
SKC	The SKC Web site archives all approved-for-release SKC Program events and includes links to the "U.S. Spacesuit Knowledge Capture Series Catalog Revision A," the CTSD (EC) Share Drive, and spacesuit-related Web sites, which include the NESC Academy Online, EA Engineering Academy, and NASA STI Program's YouTube	https://oasis.jsc.nasa.gov/orgs/EC/SpacesuitKnowledgeCapture/default.aspx	NASA community only

Figure 4. A map to SKC DAA-approved events (image by Blake Dumesnil).

V. Featured Spacesuit Knowledge Capture Event

Until FY 2015, the SKC events spoke primarily to engineers, scientists, and technical staff within the NASA community, but Scott Askew's (Figure 5) May 13, 2015 lesson, "Robonaut 2: The First Humanoid Robot in Space and its Technology Spin-offs" presented to SIPI students and faculty and interested JSC employees, expanded the borders of the SKC Program's audience.

Figure 5. Scott Askew through various phases of his work with robotics (image by Jeannie Corte).

During this presentation, Mr. Askew discussed Robonaut's development, which began at NASA JSC in 1997. Funded as a technology program to push the envelope of space robotics, its journey to space has been circuitous and required perseverance from many engineers over its lifespan. Today onboard the International Space Station (ISS), Robonaut 2 has spanned more than six crew expeditions and has been recently upgraded with walking legs. These legs will soon allow it to move inside the ISS to prepare for future robotic extravehicular activity (EVA) outside the habitation modules. Mr. Askew also discussed Robonaut technology and the ways engineers have germinated multiple new projects that are enabling future capabilities for humans in space and on Earth.

Mr. Askew received a bachelor of science from the University of Oklahoma in 1986, and a master of science from Virginia Polytechnic Institute in 1989, both in electrical engineering. He has worked in robotics at NASA JSC for 30 years specializing in motor control and sensing for mechatronic systems. From 1997 to 2003 and from 2007 to 2011, Mr. Askew served as a lead electrical engineer on NASA's Robonaut and Robonaut 2 projects. From 2004 to 2006, he participated in the NASA Administrator's Fellowship Program where he worked at Salish Kootenai College and SIPI teaching and contributing to the development of engineering programs at tribal colleges. Mr. Askew is currently serving as the rover chief engineer for the Resource Prospector Mission, which plans to send a rover to the Moon to search for resources that can be used to help extend human presence in our solar system.

VI. Southwestern Indian Polytechnic Institute

SIPI is a junior college in Albuquerque, New Mexico. It has the largest and most tribally diverse Engineering and Engineering Technology Associate of Science degree and certificate programs and is a leader in these fields of education among Tribal Colleges and Universities (TCU). SIPI's Advanced Technology, Engineering, Engineering Technology programs are fully articulated with all the New Mexico four–year universities.

The relationship between SIPI and the SKC Program began when they collaborated on a NASA grant proposal in 2013. A small piece of the proposal was dedicated to knowledge capture to facilitate increased educational experiences for students at SIPI via the SKC Program process. SIPI won the NASA grant entitled, "Information Technology Experiences Using Simulated Tele-Science Exploration of Mars." The SKC Program was activated with learning opportunities for students at SIPI whereby NASA experts have been made readily available to students in real-time-learning sessions known as knowledge capture (K-CAP) lessons. Remote access was made available to the

students through online meetings using software applications such as WebEx. The students have been learning by participating in the real-time K-CAP lessons and asking questions. As the lessons occur, they are digitally recorded for students to have electronic access to the information for future use and reference. Recordings are also stored on compact discs to make the material accessible to educators and students as necessary. The students can also access lessons and other non-sensitive technical lectures deemed public releasable on the NASA STI Program's YouTube. Some of the SIPI students benefiting from the K-CAP sessions are shown in Figure 6.

Figure 6. SIPI students, faculty, and NASA-related projects.

The NASA JSC SKC Program hosts the K-CAP lessons for the students in collaboration with SIPI. The lessons have been adaptable to SIPI's desired subject matter to enhance the learning of the students. Six K-CAP lessons were planned over a 3-year period, averaging two lessons per year, equating to approximately one lesson every six months. The NASA JSC SKC manager and the NASA JSC SKC administrator administered and guided K-CAP lessons.

The first K-CAP lesson was presented by robotics expert, Scott Askew. Scott's event is highlighted in Section V of this paper. The K-CAP lesson focused on Robonaut 2, which was the first humanoid robot in space. Mr. Askew delivered the presentation to SIPI to facilitate the study of STEM education. This presentation was provided to SIPI students who had remote access through online meetings. During this lesson, students had the opportunity to ask questions to Mr. Askew. This lesson was electronically recorded and provided to SIPI for reference and future use.

SMEs like Scott Askew, who can communicate their experiences on various levels, will educate and inspire audiences of all ages. SMEs at NASA have the capability to stimulate young minorities such as Native Americans and Hispanic students, which is critical to sustain the interest and education of STEM subjects.

Valuable STEM knowledge exists at NASA, and has been preserved through the K-CAP lessons and made easily accessible to the targeted students and educators at SIPI. Experts have taught those who were eager to learn and help enable the students to develop into future engineers, scientific discoverers, and inventors. The United States' scientific future depends on the support and interest of these targeted students and educators. By working together, SIPI and NASA, along with the students and educators, can not only sustain, but also increase America's interest in science and make possible what is now thought to be impossible.

VII. Future Outlook for U.S. Spacesuit Knowledge Capture

The spacesuit legacy has many valuable lessons, and progress is being made in sharing and making the events accessible to those who can apply them for the advancement of spaceflight. The future of the SKC Program depends on funding from year to year. The SKC Program has been pleased that the NESC support and encouragement from Mr. Hank Rotter which has continued over the last couple of years. Funding for the future is not a guarantee. However, with the extraordinary success that the SKC Program has had over the last eight years, it is hoped that the success will speak for itself to gain continued support. The SKC Program will continue to focus on archiving the events. Possible future events to be held include those listed in Table 4. And, possible future SIPI events are listed in Table 5.

Table 4. Possible Future Events

Possible Date to be Presented	Presenter	Title of Event
Spring 2016	Ken Thomas	Extra -Vehicular Activity (IEVA) Russian & Gemini
Spring 2016	Ken Thomas	IEVA - Apollo Development & Program 1960-72
Summer 2016	John Steele	Water Quality Module
Summer 2016	Mike Swickrath	Lessons in Spacesuit Air Revitalization: CO2 Capture and Humidity Control Technologies, Simulation, and Optimization
Summer 2016	Mike Swickrath	Lessons in in Spacesuit Air Revitalization: Atmospheric Monitoring and Contingencies for Off-nominal Events

Table 5. Possible Future SIPI events

Possible Date to be Presented	Presenter
Spring 2016	Dan Harrison
Fall 2016	Dr. Firouz Naderi or someone from his directorate
Winter/Spring 2017	To Be Decided

VIII. Conclusion

On March 1, 2016, NASA celebrated American astronaut Mark Kelly's record-breaking continuous time in space upon his return to Earth. With the 143 million miles that he traveled onboard the ISS during its 5,440 Earth orbits, the data collected of Mr. Kelly's physiological and psychological status during this time will be used to help prepare for NASA's future mission to send an astronaut into space beyond the Moon. During his 340 consecutive days in space, NASA encouraged Mr. Kelly and the public to interact through social media. Sharing this incredible adventure while it happened has been useful in engaging the public and encouraging support for STEM studies. In a March 2, 2016 message, NASA Administrator Charles Boldin wrote: "Scott engaged millions of people around the world with his human journey. His social media posts, his amazing photos of our planet from orbit and the video downlinks in which he shared his experiences for students around the world have certainly energized the 'space generation' to join him and NASA on our journey to the Red Planet."[11] Making valuable, stimulating information accessible to the public, especially for a government program such as NASA, which is publically funded, encourages the public to be vested and put its support and interest into a mission that can benefit future explorations

and lead to valuable discoveries for mankind. With this shared interest and knowledge, along with that shared by programs such as the SKC, NASA is exchanging useful educational data that has the potential to build better spacesuits to use when traveling to greater distances in space, and is gaining more knowledge than ever recorded in space history.

Acknowledgments

The authors thank collaborators, whose contributions help the SKC Program preserve valuable spacesuit information by recording SKC events; namely, Jim Hansen and Matthew Mcgee of the Flight Operations Directorate. Also Michael Hare of Digital Learning Network, and Lyle Tavernier of the Jet Propulsion Laboratory (JPL) have provided the capability for multiple NASA centers and public entities to view these publically approved events in real time using the JSC USTREAM channel, which added tremendously to the SKC events' viewership. We also value and thank NESC members Susan Braunheim-Davis and Ian Batchelder for their great contributions that include reviewing, editing, and synchronizing each DAA-approved video, along with adding captions to them, and archiving each file to the NESC Academy Online. We also extend our thanks to Hank Rotter and SIPI's Nader Valdi and Sandy McMahon for their commitment to continue the SKC Program, which is sustained through their contributions.

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